

You are welcome here: considerations of diversity, equity, and inclusion for embracing new ecologists

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Abstract

Ecology is working to face its colonial roots and institutional inequities. As we build more diverse, equitable, and inclusive (DEI) institutions we must work to support new ecologists by empowering them with the knowledge and tools to succeed. Undergraduate research experiences (UREs) are critical for a student's professional and interpersonal skill development and key for recruiting more diverse groups of students to ecology. Here, we highlight DEI dimensions of a URE in ecology, acknowledge safety considerations for field ecology, including harassment and assault, and provide tools to support the URE. This is written primarily for all URE students and secondarily for their advisors. We welcome students from underrepresented groups and encourage allyship from students from non-underrepresented groups. After reading this paper, we hope that all students feel more confident and excited about their URE and that advisors see how to improve DEI in their lab.

Keywords

Undergraduate research experience, diversity, equity, inclusion, science communication, mentor, ecology

“In a nutshell”

- Undergraduate students pursuing a career in ecology are encouraged to pursue an internship type of research experience taking them beyond classroom learning into a research lab.
- These research experiences are important for building technical and interpersonal skills necessary for obtaining post-undergraduate jobs and/or acceptance into higher education programs.
- Minority groups like Black, Indigenous, and people of color (BIPOC); LGBTQ+; first generation; and other identities are underrepresented in ecology.
- This paper sheds light on some of the issues ecology faces as a field, including lack of diversity, equity, and inclusion (DEI), and aims to empower all undergraduate students embarking on a research experience with knowledge and tools for success.

- Advisors play a critical role in transforming ecology into a more diverse, equitable, and inclusive field starting with their lab space and community.

An undergraduate research experience (URE) is key to building students' confidence and interest in science, technology, engineering, and mathematics (STEM) careers (National Academies of Sciences 2017). Paid UREs help students, especially those from underrepresented groups—communities that historically have been structurally excluded from US higher education (Dodson *et al.* 2009)—in STEM, gain insight to the research process and culture (Haeger *et al.* 2018). Furthermore, URE students develop technical skills and scientific identities (National Academies of Sciences 2017). Employers are particularly interested in hiring for interpersonal skills such as intercultural fluency, project management, and effective communication (Hart Research Associates 2013), all of which can be cultivated through UREs.

While the importance of UREs for career development is clear, beginning a URE can be intimidating, confusing, and overwhelming. We know from experience: all of the authors on this paper are either current undergraduates (four of us) or started their careers in ecology with a URE (seven of us). Resources exist for mentors with regards to how to best advise students including underrepresented minority students, e.g., Puniwai-Ganoot *et al.* (2018) and Montgomery (2018), but few guides exist for students themselves embarking on their first research experiences in ecology that address diversity, equity, and inclusion (DEI) or interpersonal safety considerations. This paper aims to break down some of the cultural barriers to ecology and encourage all students interested in ecology to pursue a URE.

Diversity, equity, and inclusion matter here

Because fostering a positive lab culture is critical to the safety and productivity of all researchers (Chaudhary and Berhe 2020), we begin with a discussion of the importance of supporting DEI in

UREs (Figure 1). *Diversity* is the variety of social identity groups, experiences, and worldviews that are present in a group of individuals; *equity* is equal treatment and access to resources and elimination of barriers; and *inclusion* is creating an environment that embraces differences and welcomes, respects, and values any individual or group (UC Berkeley Division of Equity and Inclusion 2015).

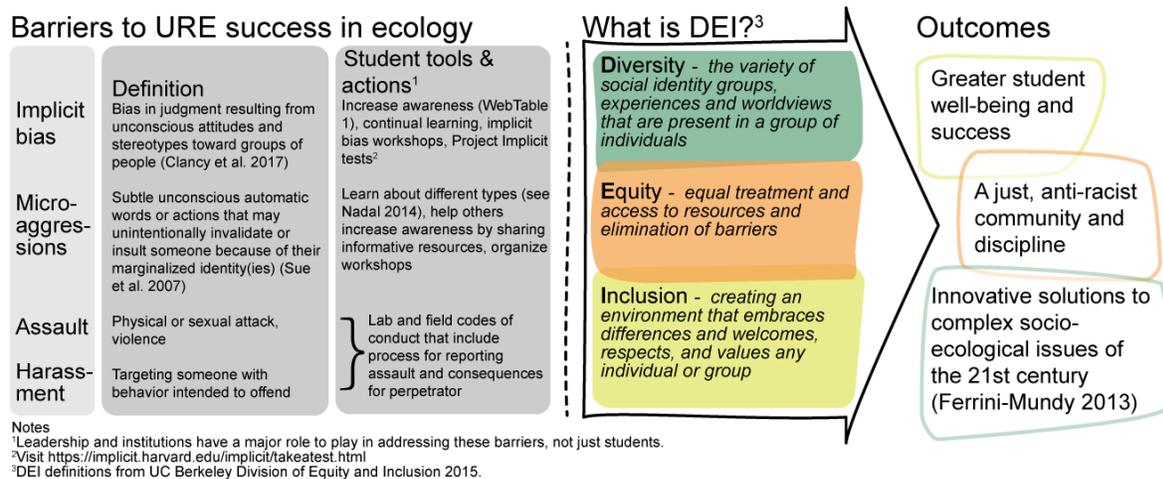


Figure 1. Breaking down barriers to undergraduate research experience (URE) success in ecology and increasing diversity, equity, and inclusion (DEI) in ecology lead to outcomes that benefit all students, ecology as a discipline, and the Earth. DEI are key for student wellbeing and success, especially underrepresented minority students. We recognize it is not the sole responsibility of students to change the system they inherit: as ecological leaders and institutions change norms and structures to eliminate barriers to DEI, ecology increases its social relevance and capacity to develop creative solutions to complex socioecological challenges.

You might already be aware that the demographics of the ecology community and STEM fields do not reflect the diversity of people in the world. For example, people who identify as Black or African American make up 13% of the US population (US Census Bureau 2018) but only 3.8% of PhDs employed at US universities and 4-year colleges (US Department of Education 2018). People who identify with minority races (including Black, Indigenous, and People of Color or BIPOC), ethnicities, genders, sexualities, economic classes, are the first in their family to attend

college, or are an intersection of these identities are underrepresented among STEM students and faculty compared to the US population (Ong *et al.* 2011; Marginson 2016; Bernard and Cooperdock 2018; US Department of Education 2018; US National Science Foundation 2019).

Correcting this disparity should be a priority for ecology, to ensure basic equity and justice for underrepresented groups. Additionally, greater diversity spurs greater innovation (Ferrini-Mundy 2013), which is critical for addressing the complex socioecological issues of the 21st century. In fact, evidence suggests that underrepresented minority STEM students are more likely to value social change as a career goal (Garibay 2015). UREs are powerful opportunities for individuals from underrepresented groups to find a sense of belonging in the STEM community and build confidence in themselves as scientists—keys for retaining such individuals in STEM (Carpi *et al.* 2017). Below we provide interpersonal considerations for students from both underrepresented and non-underrepresented groups for getting the most out of a URE and in building DEI in ecology.

We want students who identify with any minority groups or intersection of identities underrepresented in ecology to know: *You belong here!* Please know that there is a loud group of scientists advocating for you to join ecology, offering advice on how to succeed (Tseng *et al.* 2020), and to reach positions of influence. The majority of the responsibility to cultivate an inclusive, equitable workplace is on lab leadership and their institutions, but students can actively contribute. We want students who identify with non-underrepresented identities in ecology (e.g., white men and/or heterosexual individuals) to know: *You belong here!* You have a very important role to play in making the culture of STEM more inclusive.

Privilege, biases, and microaggressions 101

Each of us has a unique combination of identities that put us somewhere on a spectrum between privilege and underprivilege. A first step toward personally contributing to an inclusive lab culture is to recognize your own privilege and positionality (i.e., your privilege relative to someone else). We offer some places to start in WebTable 1. Confronting your privilege can be uncomfortable, but it is important to work through these feelings for your own well-being as well as those around you. Remember to separate your privilege from your identity as a good person—the two are not mutually exclusive (Dutt 2020). Awareness of our privilege and positionality has implications for how we interact with others, e.g., this may be your first time working with or for someone you have more or less privilege than—do you treat them differently?

A second step toward personally contributing to an inclusive lab is to educate yourself on implicit biases. Implicit biases are not character flaws; they are the result of living in a system of advantage and social conditioning (Dutt 2020). Nevertheless, they cause serious harm when left unchecked. One well-studied example of implicit bias in academia is that women professors are routinely ranked significantly lower on student evaluations of teaching compared to men professors, even when teaching methods and materials are controlled for (Boring 2017). This is because students subconsciously use different criteria to evaluate men and women professors. Less information is known about implicit biases affecting scientists and professors identifying as transgender or non-binary, but previous studies suggest that individuals identifying with these groups experience additional challenges under exclusionary workplace climates (Gibney 2019).

[**TOOL**] Explore your own implicit biases at Project Implicit:

<https://implicit.harvard.edu/implicit/takeatest.html>.

Another reason implicit biases are harmful in STEM is that they can manifest as microaggressions. These are subtle, unconscious, automatic words or actions that may unintentionally invalidate or insult someone because of their minority identity(ies) (Sue *et al.* 2007). For example, be aware of what your wording may imply: if you ask someone who is a person of color or who has an accent, “Where are you from?”, your question implies they are an outsider, which can reinforce their feelings of not belonging in the space. Instead get to know them by saying, “So, tell me something about yourself.” Your intention in the former question may be well meaning, but impact overrules intention (Utt 2013).

“So implicit bias and microaggressions are harmful, what can I do about it?”

If you are the target of a microaggression, learning about the different types of microaggressions can provide you with additional language to discuss your experience and affirm that your experience is real ([**TOOL**] see Nadal (2014)). Experts suggest you protect your emotional well-being by choosing your battles, assessing the risk of physical danger if you respond, focusing responses on the behavior and not the person, asking clarifying questions, and seeking support (Nadal 2014; Tseng *et al.* 2020).

If you are a non-underrepresented minority, you should also learn about the different types of microaggressions and consider striving for allyship—a continual process. An ally listens more than they speak, amplifies the voices of the unheard, empowers without rescuing, and is open to

being confronted about their own behavior and attitudes (Center for Community Health and Development 2019; Lamont 2019). Minority individuals are often asked formally and informally to explain their identities and to speak on behalf of entire groups of people. An ally takes on the responsibility of learning about other identity groups' experiences rather than putting the burden on individual members of these groups. **[TOOL]** To build empathy and anti-racism, we offer resources in WebTable 1 for you to learn more about the experiences of underrepresented groups. By constantly increasing your awareness of positionality and implicit biases, you can reduce and prevent their impacts on underrepresented minority students in STEM (Figure 1). **[TOOL]** Consider attending or organizing an implicit bias training to help you and your community become more effective at doing ally work (e.g., ADVANCEGeo workshops <https://serc.carleton.edu/advancegeo/workshops/>).

Communicating with your advisor

Your URE will be filled with new interpersonal relationships, including with your project advisor(s). Navigating these new relationships can be unclear, especially for first-generation students. Communicating with your advisor can feel intimidating, whether they are a professor, postdoctoral researcher (person who has their PhD but is not yet a professor or professional), or graduate student. Their credentials can easily lead to feelings of inferiority or fraud—a well-known phenomenon termed “imposter syndrome”. You may experience imposter syndrome and not feel capable of talking with your mentor (Parkman 2016), even though *you are* capable. Imposter syndrome is a particular challenge for Black students, who consistently face both implicit and explicit messaging telling them that they do not belong (Cokley *et al.* 2017). These imposter feelings have strong negative impacts on the mental health and retention of

underrepresented students in STEM (Arnold *et al.* 2020). **[TOOL]** To overcome this dilemma, we recommend you create structure around these continuing conversations by developing a mentoring plan (Montgomery 2017; Masters and Kreeger 2017; Emery *et al.* 2019). This plan can follow a formal format (e.g., an Individual Development Plan; <https://myidp.sciencecareers.org/>) or can simply be a bulleted list of important goals. Building community (check WebTable 1 for some groups and organizations) and remembering to celebrate all of your URE victories, no matter how seemingly small, can also be powerful antidotes to imposter syndrome.

As your URE progresses, be as open and honest as possible with your advisor about how your URE is going and what you hope to get out of it. After meetings, keep notes on your conversations to help you both remember what was discussed and agreed on. Realize that your advisor has many on-going projects; communicating effectively with them will require you to initiate discussions on topics that are important to you (Questad and Knapp 2007). *You've got this!*

Staying safe in the lab and field

Sometimes in the rush and excitement to get research projects going, we can overlook safety precautions. Here we provide some considerations for both physical and interpersonal aspects of safety in your URE.

Safety goggles are hip. Planning ahead is important for both accident prevention and interpersonal safety in the lab and field. To prevent accidents in labs, be proactive about your

safety and the safety of others ([**TOOL**] see lab safety checklist in Table 1). Most institutions require new lab members to undergo online safety training. After the training, ask a senior lab member about the specific safety hazards and personal protective equipment in your lab.

Hazardous items not uncommon in ecology labs include strong acids, compressed gasses, ovens, and needles. Labs with these items also have safety equipment like safety goggles and gloves, chemical waste and sharps disposal, fire extinguishers, and fume hoods. Knowing how to use the safety equipment in your lab will make you and the lab safer.

Be prepared. Often field work is conducted in isolated locations with limited cell phone service, which makes it of utmost importance to prepare carefully ahead of time. [**TOOL**] Our field safety checklist (Table 2, informed by ADVANCEGeo Partnership (2019)) covers many situations to prepare for. Know that *this is your project to take ownership of, and it's ok to make mistakes*. Think about what you will need to have with you in the field to collect the right data for your research question; go over field methods step by step with your mentor. Consider steps you can complete ahead of time so you are less rushed in the field, such as labelling your sample containers. Ask yourself what backup supplies you might need so you can still collect meaningful data when something goes wrong, e.g. batteries and duct tape. See field work as an opportunity for you to practice being a field ecologist, which includes the ability to adapt to your changing surroundings, improvise around unforeseen mishaps, and take it all in stride.

Table 1. Lab safety checklist.

Before lab work

- Study your lab's code of conduct and safety protocols. If your lab doesn't have a code of conduct, talk to your advisor or PI about making one; for examples see <https://serc.carleton.edu/207402>.
- Know where all safety equipment is located, e.g., safety showers, fire extinguishers, and personal protective equipment.
- Understand what to do in case of an emergency: where to go, who to contact.

During lab work

- Always pour volatile chemicals in a fume hood and add concentrated acid to water, not the other way around.
- Wear clean gloves when working with harmful materials or samples your skin might contaminate.
- Wear safety glasses and any other personal protective equipment as recommended.
- Place broken glass or used sharps into their proper containers—not the trashcan!
- Be aware of any potential sources of danger (e.g., chemicals, sharps, biohazards, gas tanks) and, if necessary, how to handle them safely.
- Ask questions if you are unsure of something.
- Avoid working in the lab alone or at odd hours.

After lab work

- Put away or dispose of hazardous materials into their appropriate locations.
- Clean up the work station.
- Wash your hands.

Table 2. Field safety checklist (informed in part by ADVANCEGeo (2019)).

Before fieldwork

- Study your lab's fieldwork code of conduct.
- Discuss field methods and any potential hazards.
- Establish a safety plan, including contacts for emergencies.
- Create an itinerary with departure and return times and sampling locations (map).
Share these with someone at the lab.
- Pack a well-supplied first aid kit and vehicle emergency supplies.
- Pack plenty of water, sunscreen, insect repellent, and EpiPen if necessary.
- Ask your mentor what clothing and footwear they recommend.
- Be prepared for unexpected weather changes (e.g., bring rain gear).
- Bring toilet paper, a hand trowel, and hand sanitizer for when nature calls.

During fieldwork

- Park your vehicle in a safe location.
- Maintain exit options: transportation and communication devices should be available to all field crew members whenever possible.
- Maintain awareness of any potential sources of danger.
- Wear a bright vest for visibility.

After fieldwork

- Notify lab members that you made it back safely.
- Put away or dispose of hazardous materials appropriately.
- Shower and change your clothes ASAP in case you contacted poisonous (allergenic) plants or brought home any ticks.
- Wipe down with alcohol any equipment that touched poisonous plants.

Got your clipboard and sunscreen? Don't forget interpersonal safety with field work

Interpersonal safety is just as important as physical safety and requires just as many proactive steps. *Trigger warning: This section deals with the existence, but not details, of harassment and assault.*

Positive field experiences can inspire a career, but toxic field experiences can be devastating for the individual and contribute to low retention of underrepresented groups in ecology (Nelson *et al.* 2017; Marín-Spiotta *et al.* 2019). Know that the vast majority of UREs will be both

enlightening and safe! Some of us co-authors refer to our UREs, even 15 years later, as the “best summer of my life.” However, the unique circumstances of field work can bring unique vulnerabilities. Knowledge is power, and we want you to know harassment and assault can occur anywhere, including in the field. For example, of 500 women surveyed from the Earth Science Women’s Network, 51% reported being harassed at some point in their career (Archie and Laursen 2013). In a survey of over 600 field archaeologists, 71% of women and 41% of men reported being the targets of inappropriate comments, and 26% of women and 6% of men reported experiencing sexual assault while in the field (Clancy *et al.* 2014). Further, individuals from underrepresented groups are more likely to experience harassment and assault (Clancy *et al.* 2017).

What about field work makes individuals especially vulnerable to harassment and assault? Field work can mean unfamiliar cultural norms, long days of physically exhausting work, and harsh environmental conditions (ADVANCEGeo Partnership 2019). Further, racism and heterosexism expressed by onlookers, property owners, or police heighten the risks of harassment and assault for Black and/or LGBTQ+ ecologists, e.g., Lanham (2020), Jones (2018). It is the responsibility of the field team leader to cultivate a group dynamic that promotes and champions inclusive and equitable expectations for interpersonal behavior—including a code of conduct that addresses sexual harassment, discrimination, and bullying (Schneider *et al.* 2018). **[TOOL]** For example codes see ADVANCEGeo Partnership (2020). Stay with a buddy, and make sure you know and trust at least one of the team leaders actually going in the field.

Know that your wellbeing and safety are more important than the research. If you experience harassment, assault, or anything unsafe you do not have to tolerate it—period. You do not have to tolerate it because people are counting on you for data—forget the data. This sounds obvious, but in our experiences this is rarely made clear amidst the excitement for research and rush for data. If you experience harassment or assault, keep a written record of specific incidents, including the date, people present, and what was said or done. You have rights (e.g., Title IX and Title VI) and universities have special offices with names like “Office of Inclusion and Equity” or “Office of Institutional Opportunity and Access” for reporting discrimination, harassment, and assault; keep in mind that the primary function of these offices is to make sure the institution complies with the law, and they are often not centered around the needs of the individual who experienced trauma (Cantalupo and Kidder 2019; Cantalupo 2019). If you are comfortable, speak to your project advisor or, if your URE is at a different university, an advisor from your home institution. Postdoctoral researchers, graduate students, and your internship program director are also resources for support. Keep in mind, however, that professors and most university staff are mandatory reporters of harassment and assault. **[TOOL]** Counseling services are likely available at your summer or home institution in person or remotely—these services are usually confidential (WebTable 2). Social media can also be a place to find support and solidarity (WebTable 1). Consider finding an ally who can help you navigate the situation—you do not have to get through it alone.

Now that you are empowered with this knowledge, you are better prepared to bypass or handle these situations. Should they unfortunately occur, remember that harassment and assault are *never* the fault of the person experiencing it. Despite these possible outcomes, field work is most

often an incredible opportunity for personal growth, immersive learning, and building lifelong friendships. This knowledge and careful preparation for field work should help your field work go smoothly with less stress, so your mind is able to pay attention to more of the subtle sights and sounds of your field site.

What's ecology doing about DEI?

Ecologists of all career stages are working to build a diverse, equitable, inclusive, and just field. Our discipline's roots in colonialism and how that legacy lives on today is becoming more widely explored and acknowledged, e.g., Purdy (2015) and Kean (2019). Programs such as ESA Strategies for Ecology Education Diversity and Sustainability (SEEDS) help to recruit and retain underrepresented minorities including BIPOC into ecology. Still, much work remains to transform the discipline itself (institutions, their processes, funding structures, and culture) into actively anti-racist and inclusive communities that foster the diversity of people and knowledges necessary for addressing complex socioecological issues of the 21st century.

Conclusion

UREs are key for recruiting new students and more diverse groups to ecology and are opportunities for students to develop interpersonal skills applicable to many jobs. Here, we discussed topics that will help empower undergraduates by de-mystifying ecology lab culture, welcomed students from underrepresented groups in ecology, and shared resources for building allyship in students of privilege. This paper is intended to break down barriers, so that all students can take on their URE with confidence, as an important and transformative step in their ecological pursuits. *Good luck and have fun out there!*

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